

Seabed Variability and its Influence on Acoustic Prediction Uncertainty

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LONG-TERM GOALS

- Assess and characterize uncertainty in the tactical naval environment
- Determine the impact of seafloor variability on acoustic prediction uncertainty.

OBJECTIVES

- (1) Use computer- and laboratory-generated strata to forward model sea-bed acoustic properties (e.g., elastic moduli, velocity and attenuation) in a variety of littoral settings, and provide statistical measures of these modeled properties for use in simulating acoustic propagation and reverberation.
- (2) Generate synthetic seismic data of the computer- and laboratory-generated strata for use in testing high-resolution geoaoustic inversion methods.

APPROACH

Shallow-water acoustic propagation is often strongly affected by interaction with the seafloor. The degree to which the propagation is modified by the seabed's acoustic properties is not well understood because the natural variability of these properties is difficult to thoroughly document. Process-based computer and laboratory models of shallow water strata offer two novel avenues for helping address this problem. The first is that these models provide predictions of the statistical distributions of the acoustic properties in different shallow-water settings. Secondly, these models can be used as "virtual" seabeds for constraining the impact of different but completely known mixtures of the properties on acoustic propagation and reverberation.

In this study, both computer- and laboratory-generated strata will be used to simulate acoustic properties and their impact on seismic/sonar data. The computer-generated strata will be produced by SEDFLUX (Syvitski et al., 1999). The laboratory-generated strata is that formed in the Experimental Earthscape (XES) Basin at the St. Anthony Falls Laboratory of the University of Minnesota.

Stratigraphic simulations produced by SEDFLUX contain many but not all of the acoustic properties needed to model acoustic propagation and reverberation. And none of these properties are directly obtained from the experimental strata produced in the XES Basin. To overcome these limitations, we have developed a technique for creating realistic models of these properties from digital photos of the

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laboratory-generated strata. And elements of this technique can also be applied to the SEDFLUX simulations to round off the acoustic properties needed for them.

Once these properties have been solved for, they can be used to estimate their natural variability. Furthermore, the properties can be used to create synthetic seismograms of varying realism of the experimental/computer strata. This synthetic data will eventually be used to test inversions of seismic data for acoustic properties, which in this case are completely known.

WORK COMPLETED

- Generated 2D realizations of attenuation and compressional and shear wave speeds (via Biot (1962) theory) for the New Jersey Shelf using computer-modeled strata produced by I. Overeem and J. Syvitski of INSTAAR (Figure 1).

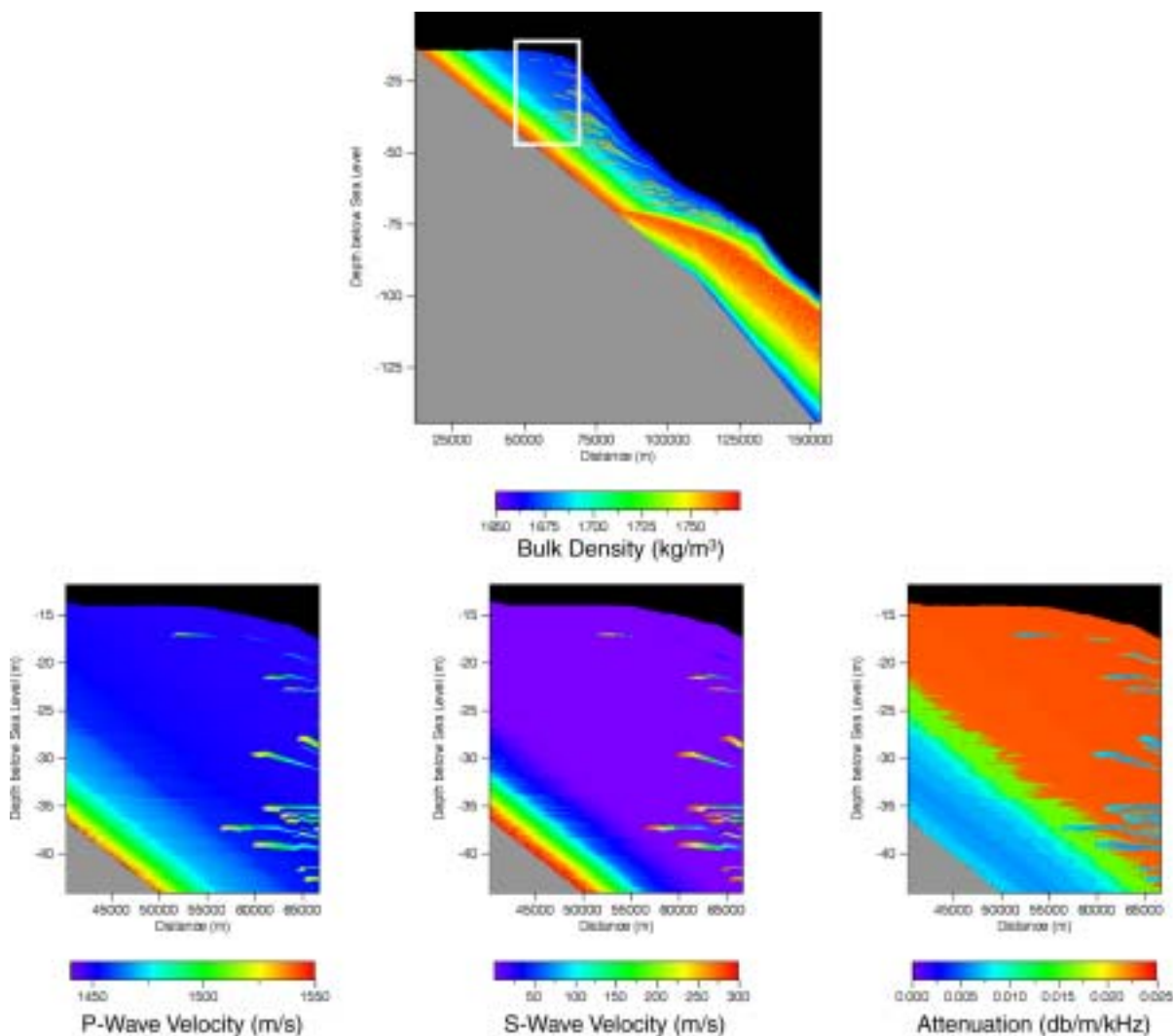


Figure 1. P- and S-Wave velocities and attenuations (bottom row) modeled from SEDFLUX prediction of strata (top) preserved on the New Jersey margin since the late Pleistocene.

- Modeled geoacoustic properties of experimental strata depicting buried shelf channels to test modeling linkage with K. LePage.
- Prepared a report on the surface geology of the GEOCLUTTER and PRIMER study areas to help other DRI teams assess how best to extrapolate geoacoustic properties measured in the GEOCLUTTER area to the PRIMER area.
- Worked with J. Syvitski and E.Hutton at INSTAAR to get the Duke physical property and synthetic seismic modeling codes up and running at INSTAAR.
- Submitted a manuscript on the Duke physical property model to *Geophysics*.

RESULTS

The most important results from the work of this year are:

- Procedures are now in place for accepting stratigraphic simulations from INSTAAR, modeling acoustic properties of these and providing the modeled properties to C. Holland, K. LePage and B. Odom for use in further modeling of acoustic propagation and reverberation.
- The compressional and shear wave speeds as well as attenuations computed from the INSTAAR stratigraphic simulations of the New Jersey shelf (Figure 1) appear to be in line with common values for these properties, but a quantitative/statistical comparison of the modeled properties against actual GEOCLUTTER measurements still needs to be done.

IMPACT/APPLICATIONS

The modeled acoustic properties will aid other members of the Seabed Variability team to simulate variability in acoustic propagation and reverberation associated with the seabed. Furthermore, this work plus the report on the GEOCLUTTER and PRIMER areas will provide other teams within the Uncertainty DRI (particularly the teams doing an end-to-end investigation of uncertainty) critical information required to carry the effects of seafloor variability all the way through to an estimation of uncertainty in Fleet Prediction Products (e.g., tactical decision aids).

TRANSITIONS

The following products have been or are being transitioned to other Uncertainty Teams:

- The report on the surficial geology of the GEOCLUTTER and PRIMER study areas.
- The 2D realizations of geoacoustic properties (P- and S-speeds/attenuations) on the NJ shelf.

RELATED PROJECTS

ONR STRATAFORM/EuroSTRATAFORM: Synthetic seismic modeling of deposits produced by shelf processes as simulated in computer and experimental stratigraphic models.

REFERENCES

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FY02 PUBLICATIONS

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